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REVIEW OF THE INDO-PACIFIC PIPEFISH GENUS  
*CHOEROICHTHYS* (PISCES: SYNGNATHIDAE), WITH  
DESCRIPTIONS OF TWO NEW SPECIES

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Recent major works on Indo-Pacific pipefishes (Weber and De Beaufort, 1922; Herald, 1953; Smith, 1963) were based largely on compilations from the literature and examination of relatively few specimens. A number of early errors and inaccuracies have thereby been perpetuated and, for the most part, there is little useful information available on intraspecific variation or geographic distribution. Unlike my predecessors, I have been able to examine collections, of the International Indian Ocean Expedition and several more recent expeditions, from over much of the tropical Indo-Pacific region. These materials and other museum holdings provide the basis for this report on *Choeroichthys*, an abdominal pouch genus of pipefishes (Syngnathidae: Gastrophori).

METHODS AND MATERIALS

Measurements of standard length (SL) were made on a measuring board, graduated in 0.5 millimeter (mm) intervals, and estimated to the nearest 0.5 mm under low-power magnification; snout depth was taken with an ocular micrometer; other measurements were made with needlepoint dial calipers and recorded to the nearest 0.1 mm. All fin-rays were counted separately. Except in damaged or anomalous specimens, anal and caudal fin-rays are, respectively, 4 and 10 in all species of *Choeroichthys* and routine counts are omitted; fish with atypical caudal fin-ray counts were considered to

have regenerated tails and were omitted from data on ring counts and proportional measurements.

Measurements requiring special definition follow: SL—straight-line distance from tip of lower jaw (mouth closed) to articular base of median caudal fin-rays; head length (HL)—tip of lower jaw to rear margin of opercle; snout length—tip of lower jaw to anterior inner margin of bony orbit; minimum snout depth—least vertical dimension of snout posterior of gape; pectoral fin length—length of longest fin-ray from articular base to tip; length of pectoral fin-base—straight-line distance between articular bases of upper and lowermost rays; length of dorsal fin-base—distance between anterior and posterior angles of insertion; anal ring depth—minimum distance between outer margins of superior and inferior trunk ridges on ring bearing anus. Counts of trunk rings begin with that bearing pectoral fin-base and end with that bearing anus; counts of tail rings begin with that bearing anal fin and end with penultimate ring, excluding terminal element bearing caudal fin-base. In the few cases where anus and anal fin occur on the same ring, the minimum trunk ring count is recorded (e.g. 16 rather than 16.5). Positional relationship of dorsal-fin base to trunk and tail rings is estimated to the nearest fourth of ring length and indicated by the formula: trunk rings covered + tail rings covered = total rings covered by dorsal fin-base (subdorsal rings). Color descriptions are from specimens preserved in alcohol.

Materials examined are listed by general localities from west to east and roughly north to south; depths are reported in meters (m). Maps delineate general distribution and do not show all collection sites.

Abbreviations for repositories of examined material: AMS—Australian Museum, Sydney; AMNH—American Museum of Natural History; ANSP—Academy of Natural Sciences, Philadelphia; BMNH—British Museum (Natural History); BPBM—Bernice P. Bishop Museum; CAS—California Academy of Sciences; CAS-SU—former Stanford University specimens housed at CAS; FMNH—Field Museum of Natural History; GCRL—Gulf Coast Research Laboratory Museum; HJ—

Hebrew University of Jerusalem; LACM—Natural History Museum, Los Angeles Co.; MCZ—Museum of Comparative Zoology; MNHN—Museum National d'Histoire Naturelle, Paris; QM—Queensland Museum; RMNH—Rijksmuseum van Natuurlijke Historie; RUSI—J. L. B. Smith Institute of Ichthyology, Rhodes University; UG—University of Guam; UMMZ—Museum of Zoology, University of Michigan; USNM—National Museum of Natural History, Smithsonian Institution; WAM—Western Australian Museum.

*Choeroichthys* Kaup

*Choeroichthys* Kaup, 1853:233 (name only, nomen nudum). Kaup, 1856:55 (type-species by original designation, *Choeroichthys valencienni* Kaup, 1856 equals *Syngnathus brachysoma* Bleeker, 1855).

*Diagnosis:* Superior trunk and tail ridges continuous, lateral trunk ridge continuous with inferior tail ridge, inferior trunk and tail ridges discontinuous near anal ring; scutella with or without keels, with or without knoblike projections on posterior margins of rings below lateral trunk ridge; lateral and median dorsal snout ridges present; opercle with complete median longitudinal ridge and additional ridges above and below; margins of head and body ridges smooth, finely denticulate or somewhat serrate; snout length 1.5–2.5 in head length; trunk rings 14–21; tail rings 17–25; subdorsal rings 3.75–8.25, mostly on trunk; dorsal fin-rays 17–34; pectoral fin-rays 18–23; anal fin-rays 4; caudal fin-rays 10. Brood pouch abdominal; pouch protective plates and brood pouch folds present; brood pouch eggs in two longitudinal rows (1–2 layers deep), covered by protective dermal folds which meet with somewhat inverted margins along ventral midline. Odontoid processes present on premaxillae and dentaries. Maximum size about 80 mm SL. Indo-Pacific.

*Remarks:* Confusion exists in the literature concerning brood pouch morphology in this genus. Weber and De Beaufort (1922) and Smith (1963) imply that brood pouch folds are united, or temporarily united, along the ventral midline; Herald's (1953) generic key states that pouch folds are absent in *Choeroichthys*. I find that pouch folds completely cover the eggs and that fold margins are always free and curved slightly dorsad along midline of egg-filled pouch (Fig. 9). In most egg-bearing males, the eggs are in a single layer of two parallel longitudinal rows, but 3–4 rows (1.5–2 layers) are present in some specimens.

Dawson and Fritzsche (1975) reported the occurrence of odontoid processes (Fig. 1) on one or both jaws in three genera of abdominal-pouch pipefishes: *Syngnathoides* Bleeker, *Heraldia* Paxton and *Choeroichthys*. Although lacking pulp cavity and enamel layer of true teeth, it is assumed that these bony projections function as teeth and

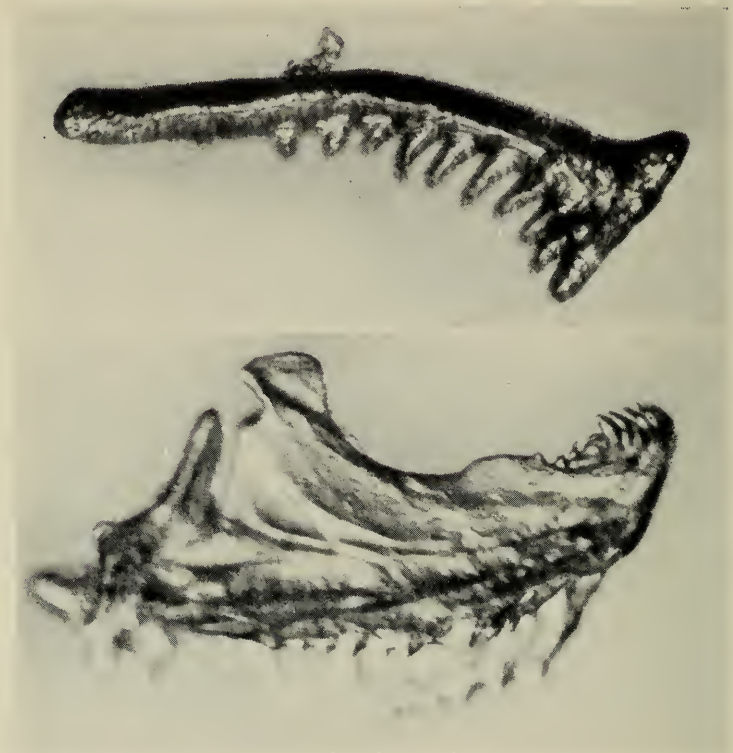


FIG. 1. Odontoid processes in *Choeroichthys sculptus*. Top: Right premaxilla, length ca. 0.8 mm. Bottom: Left mandible, length ca. 0.9 mm.

that specialized feeding modes (grazing?) have developed in "toothed" pipefishes. Apparently vestigial in *C. smithi*, these processes are well developed and usually visible under  $\times 30$  magnification in subadult and adult congeners.

Smith (1963) considered the smooth or serrate character of bony ridges to be of systematic importance in this genus, but ridges vary from almost smooth to serrate in both *C. brachysoma* and *C. sculptus*. Trunk ring counts show little variation in a number of groups of pipefishes (Herald and Randall, 1972; Dawson, 1974) but this is not so in *Choeroichthys*. The most frequently collected species (*brachysoma* and *sculptus*) exhibit geographic variation in modal trunk ring frequencies but these variations are presently unexplained. I find no other significant intraspecific differences.

## KEY TO THE SPECIES OF CHOEROICHTHYS

1. Scutella of trunk and tail keeled (Fig. 9); dorsal fin-rays 27–34; subdorsal rings 6.25–8.25 .....*C. sculptus* (Günther)  
Scutella not keeled (Fig. 3); dorsal fin-rays 17–26; subdorsal rings 3.75–6.0 ..... 2.
2. Snout short, its depth less than 3 in length; trunk rings 18–19; dorsal fin bicolored, dark in front and pale posteriad.....  
.....*C. smithi* n. sp.  
Snout longer, its depth more than 3.5 in length; trunk rings 14–18 (99.6% with 17 or fewer); dorsal fin not bicolored, mainly pale throughout ..... 3.
3. Without knoblike projections below lateral ridge on posterior margins of trunk rings; head length averages about 5 in SL; tail rings 17–20 (fewer than 20 in 93% of specimens); sides of trunk plain or with one or two rows of small dark spots; body without bars .....*C. brachysoma* (Bleeker)  
Males (females?) with distinct knoblike projections below lateral ridge on posterior margin of most trunk rings (Fig. 6); head length about 4 in SL; tail rings 20–21; body with dark bars (at least in males) .....*C. cinctus* n. sp.

*Choeroichthys brachysoma* (Bleeker)

Figures 2 and 3

*Syngnathus brachysoma* Bleeker, 1855:327 (original description, Batu Archipelago).

*Choeroichthys valencienni* Kaup, 1856:55, pl. 3 (original description, Isle of Bourbon).

*Doryichthys serialis* Günther, 1884:30, pl. 3 (original description, Port Moller, Queensland).

*Choeroichthys suillus* Whitley, 1951:393 (original description, Port Denison, Queensland).

*Diagnosis:* Scutella not keeled; without knoblike projections below lateral trunk ridge on posterior margins of rings; snout depth more than 3.5 ( $\bar{x} = 4.5$ ) in snout length; head length averages about 5 in SL; rings total 31–37; dark lateral stripe on snout and opercle; with or without rows of dark spots on trunk; body without bars; dorsal fin not bicolored.

*Description:* Dorsal fin-rays 18–26 ( $\bar{x} = 21.4$ ); rings 14–18 + 17–20 = 31–37; subdorsal rings 2.5–5.5 ( $\bar{x} = 3.8$ ) + 0–1.75 ( $\bar{x} = 0.8$ ) = 3.75–6.0 ( $\bar{x} = 4.6$ ). See Tables 1–4 for additional counts and measurements.

Ridges variously smooth to finely serrate; median dorsal snout ridge low (Fig. 3); lateral snout ridge sublinear, not strongly arched; usually with 2–4 prominent suborbital ridges; other head ornamentation variable; pectoral cover plate with two longitudinal ridges, often additionally ornamented with short low ridges. Trunk and tail ridges deeply notched

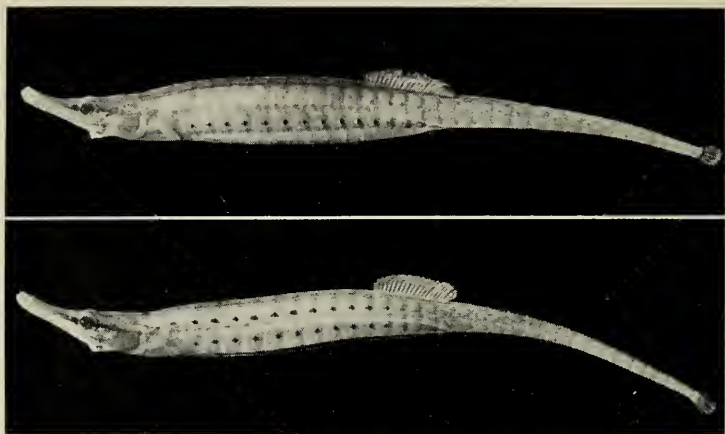


FIG 2. *Choeroichthys brachysoma* (Bleeker). GCRL 13849, Australia. Top: Male, 54 mm SL. Bottom: Female, 52 mm SL.

or but slightly indented between rings; posterior angles of tail rings produced as short pointed spines, merely pointed, or occasionally rounded or truncate. Scutella inconspicuous, without keels; without projecting knobs on rear margins of trunk rings; ring surfaces not strongly depressed between ridges, usually with finely reticulate ornamentation. Odontoid processes distinct in most specimens.

Ground color tan to dark brown; plain, marbled or with faint irregular stripes. Typically with prominent dark stripe on side of snout and across all or most of opercle. Females usually with a row of small dark spots above and below lateral trunk ridge. Most males with upper spots restricted to 1st through 3rd and last 4 or 5 trunk rings, and with complete row of spots below; spots may be obsolete in some males or two complete rows of spots may be present. Trunk of males often margined with dark brown; pigmentation of brood pouch folds usually replicates ground color, but folds covered with rather large dark spots in some Australian specimens (ANSP 113482; GCRL 13861). Dorsal fin immaculate or with faint scattering of brown flecks along rays and fin base; pectoral rays often flecked with brown; caudal fin brownish with pale distal margin.

Smallest examined male with eggs in pouch (29.5 mm SL) contained 24 eggs in two rows of 12. A 51 mm specimen had pouch folds extending along 15 rings with eggs beneath 12; there were two rows, each with 21 eggs in the outer of two layers.

*Discussion:* Among examined material (Fig. 4, Table 4), modal trunk ring counts of 14 occur only in collections from Singapore, the northern Gulf of Thailand, and in three small lots from Palau. The count is

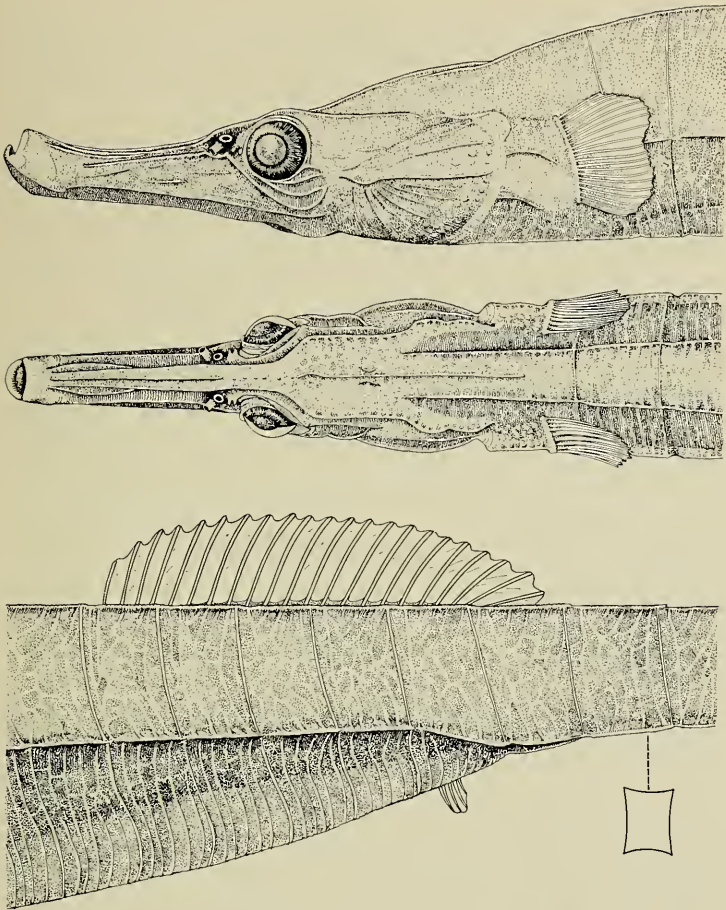


FIG. 3. *Choeroichthys brachysoma*. Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail ring. From 56 mm SL male, USNM 173706.

modally 15 in Australian, Solomon Island and most other western Pacific samples. Trunk rings are usually 16 throughout the Red Sea-Indian Ocean region and in a number of small collections from the Mariana, Cook and Society islands. Total ring frequency averages 35 in Red Sea-Indian Ocean material and 33 in Pacific collections, but I find no substantial differences in these populations. *Choeroichthys*

*brachysoma* exhibits considerable variation in development of head and body ridges and in ground color. I find no consistent trends in character of ridges (e.g. smooth or rough); Australian material is darker than most, but dark specimens are not uncommon elsewhere (Mozambique, Philippines, etc.).

Bleeker's holotype (RMNH 7250) is now completely faded and the snout is damaged. Ridges are rather strongly denticulate and distinctly notched between rings; most tail rings with posterior angles produced as shore spines. This male specimen (ca. 49.5 mm SL) has two sub-orbital ridges on the left and three on the right side; the empty brood pouch extends beneath 13 trunk rings. See Tables 1, 2 and 4 for additional data.

Kaup (1856:55) reported the holotype of *C. valencienni* from the Isle of Bourbon (Reunion Is.) and also (p. 75) from Ile de France (Mauritius). Data from this specimen are here included under Mauritius (Table 4). The holotype of *Choeroichthys suillus* Whitley was differentiated from *C. brachysoma* by differences in ring counts and coloration, and by the smooth character of the ridges. Whitley (1951) reported 18 + 20 rings, 5 + 1 subdorsal rings, 21 dorsal, 18 pectoral and 5 anal fin-rays. I count 18 + 19 rings, 5 + 0.5 subdorsal rings, 24 dorsal, 21 (2) pectoral and 4 anal fin-rays in this specimen (AMS IA.1806). Although somewhat faded, traces remain of a snout-opercular stripe and diffuse brown blotches persist above the lateral ridge on 6 or 7 anterior trunk rings; no indication remains of ". . . light blotches across back." reported by Whitley. Head and body ridges are largely smooth, head ornamentation is minimal, and ring surfaces are somewhat striate. This specimen falls within known variation of *C. brachysoma* in all measurements and counts except frequencies of trunk and total rings; there is one more trunk ring (two more than in other Australian samples), and the total ring count is higher by one (Table 4). The described pale bars on the dorsum and the dusky trunk blotches are unusual, but the persistent snout-opercular stripe is characteristic of *C. brachysoma*. A similar stripe and barred dorsum also occur in *C. sculptus*, but the keeled scutella of this species are absent in the holotype of *C. suillus*. This nominal species therefore differs from *C. brachysoma* in ring count and surface ornamentation (both variable in *brachysoma*), and in some color markings. Pending collection of additional material I treat the type of *C. suillus* as a variant of *C. brachysoma*. *Choeroichthys suillus mallus* Whitley (1954) was synonymized with *Doryrhamphus melanopleura* (Bleeker) by Paxton (1975).

*Distribution:* *Choeroichthys brachysoma* ranges from the Gulf of Aqaba in the Red Sea to the Society Islands (Fig. 4). The species is infrequently collected to the east of the Solomons, and it is largely replaced by *C. sculptus* throughout the tropical central Pacific. Although available data show most specimens as being taken in depths of less than 5 m, there is one SCUBA collection from 21.3–27.4 m in the Seychelles.



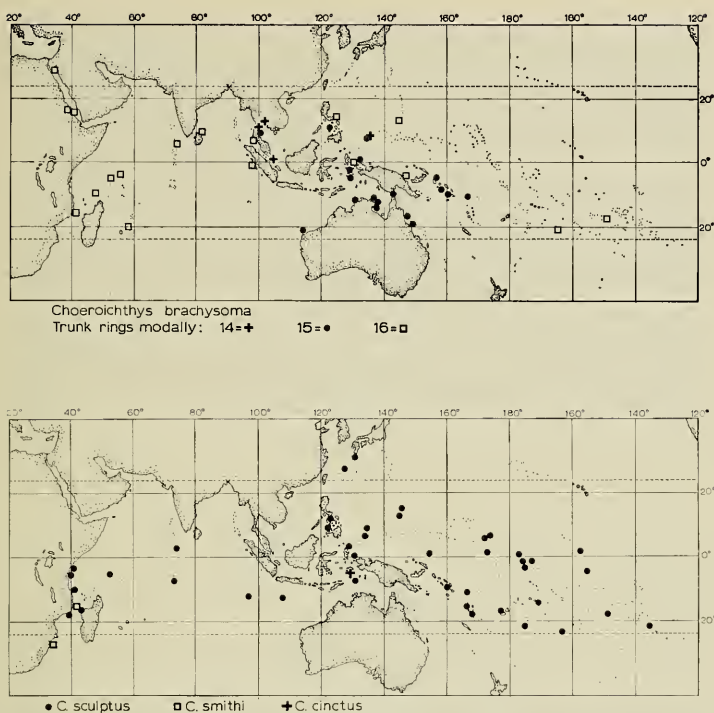


FIG. 4. Distributions of species of *Choeroichthys* as determined from material examined.

*Material examined*: 286 specimens, 13.5–62.5 mm SL, including holotype: RED SEA: Israel: HJ E.62-487. Gulf of Aqaba: USNM 214537, 214575, 214578. Ethiopia: HJ E.62.4025; GCRL 13858; USNM 214532, 214538, 214576, 214579. INDIAN OCEAN: Mozambique: RUSI 3787, 3788, 3790–3792. Aldabra Is.: USNM 214536, 214539. Seychelles: ANSP 108966, 108974–108977, 108986, 108989, 108999, 110039; USNM 214526. Mauritius: BPBM 16301; MNHN 6037 (holotype of *C. valencienni*). Maldive Is.: FMNH 75867. Ceylon: GCRL 13859; USNM 214530, 214531, 214534, 214577, 214580. Thailand: GCRL 13862; USNM 214527. Batu Archipelago: RMNH 7250 (holotype of *Syngnathus brachysoma*). PACIFIC OCEAN: Singapore: BMNH 1952.12.16.9–10; CAS-SU 34957, 39417, 39418; FMNH 47186; GCRL 13860. Gulf of Thailand: CAS 32271, 32278, 32279. Philippine Is.: CAS 32273, 32276; USNM 137270, 137272, 214624. Molucca Is.: RMNH 21105; USNM 210655, 210656, 214535. Palau Is.: CAS 32261–32268, 32270, 32272, 32277. New Guinea: CAS-SU 26687; USNM 214533.

Australia, Western Australia, Monte Bello Is.: BMNH 1913.12.6.10. Australia, Northern Territory: AMS IA.4401; GCRL 13849; USNM 173703-173707, 173709. Australia, Queensland: AMS IA.1293, IA.1806 (holotype of *C. suillus*), IA.5731, IA.6187; AMNH 32451-32453; ANSP 113482, 119350; BMNH 1881.10.12.29;82 (two syntypes of *Doryichthys serialis*); GCRL 13861; QM 10858. Mariana Is.: CAS 32274. Solomon Is.: BPBM 16248; CAS 19947, 19950; GCRL 13714; USNM 214528. New Hebrides: CAS 32275. Cook Is.: BPBM 5685, 18611. Society Is.: CAS 32269; FMNH 75876.

***Choeroichthys cinctus*, new species**

Figures 5 and 6

*Diagnosis*: Scutella not keeled; males (females?) with knoblike projections below lateral ridge on posterior margins of most trunk rings; snout depth more than 3.5 (4.3-5.8) in its length; head length about 4 in SL; tail rings 20-21; males (females?) with dark bars on body; dorsal fin not bicolored.

*Description*: Dorsal fin-rays 22-25; rings 15 + 20-21 = 35-36; subdorsal rings 3.5 + 1.25-1.5 = 4.75-5.0. Measurements (mm) of holotype follow: standard length 38.0; head length 10.0; snout length 5.8; minimum snout depth 1.0; length of dorsal fin-base 4.0; length of pectoral fin-base 1.1; caudal fin length 1.8; anal ring depth 1.7. See Tables 1-3 for additional data.

Ridges rough, finely denticulate to serrate; median dorsal snout ridge low (Fig. 6); lateral snout ridge sublinear, not strongly arched; usually with one suborbital ridge; opercle more or less waffled by intersecting ridges above and below median longitudinal ridge; pectoral cover plate with some irregular low ridgelike sculpturing and two longitudinal ridges. Trunk and tail ridges distinctly notched between rings; posterior angles of tail rings pointed, produced as short spines in holotype. Posterior margins of all but 1st through 3rd trunk rings with knoblike lateral projections located about midway between lateral ridge and base of pouch protective plates; these are best developed over posterior trunk rings. Scutella inconspicuous, without keels; ring surfaces distinctly depressed between ridges and between anterior and posterior margins, finely ornamented with irregular lines but not striate. Odontoid processes prominent and rather sharply pointed in study material, 8-9 projections on right premaxilla and 6-7 on left dentary of holotype.

Ground color tan to near white. Without distinct stripe on snout or opercle, but with brown preorbital blotch and a larger diffuse blotch dorsolaterally behind eye; underside of lower jaw, dorsum and sides of snout elsewhere shaded with microchromatophores; dorsum of head behind eyes, suborbital, opercle and pectoral cover plate with rather large diffuse spots or blotches. Sides of trunk with prominent series of partial or complete brown bars, each bisected by pale vertical line at juncture of adjacent rings; bars less regular or blotchlike on dorsum

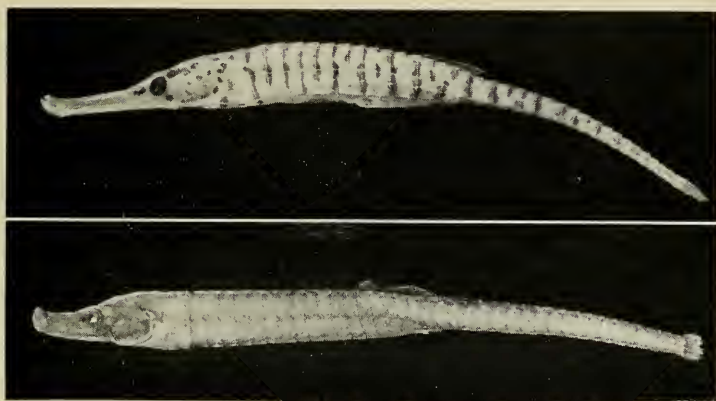


FIG. 5. Top: *Choeroichthys cinctus* n. sp. USNM 214567, holotype, 38 mm SL, male. Bottom: *Choeroichthys smithi* n. sp. RUSI 3744, holotype, 44 mm SL, female.

and on sides and venter of tail; interspaces pale or shaded with chromatophores; lateral trunk ridge and tips of knoblike projections pale; venter of 1st and 2nd trunk rings blotched; one or two diffuse blotches anteriorly on brood pouch folds of holotype and one paratype (BPBM 18610), folds otherwise pale; ventral margins of pouch protective plates narrowly lined with brown. Dorsal and pectoral fins with light basal scattering of chromatophores, immaculate elsewhere; caudal fin of one fish (BPBM 18610) with pale base and distal margin and broad brown bar between, fin mainly pale in other material. Dr. J. E. Randall noted life coloration as "pale yellowish with dark brown broken bars."

Brood pouch folds originate near middle of 3rd trunk ring in one fish (BPBM 18610), at anterior margin in remainder; pouch folds encompass 13 rings in holotype and the pouch contains two rows of three eggs each beneath 10th–13th rings; other specimens without eggs.

*Etymology*: From the Latin *cinctus*, surround or gird, in allusion to the barred color pattern of preserved males.

*Comparisons*: Males of *Choeroichthys cinctus* are readily separable from all congeners by their banded coloration and by the projecting knobs on lower sides of trunk. It is problematical whether this color pattern is replicated in females, but I expect the lateral projections to be present in both sexes. This species lacks the keeled scutella of *C. sculptus*, lacks the bicolored dorsal fin of *C. smithi*, and has fewer trunk rings than either (15 against 18 or more in *sculptus* and *smithi*). The slender snout and sublinear lateral snout ridge suggest closer relationship to *C. brachysoma*. Head length is apparently somewhat longer in *C. cinctus* (averaging 3.5 in SL against 5.0 in *brachysoma*), and tail ring counts (20–21) exceed those of most examined.

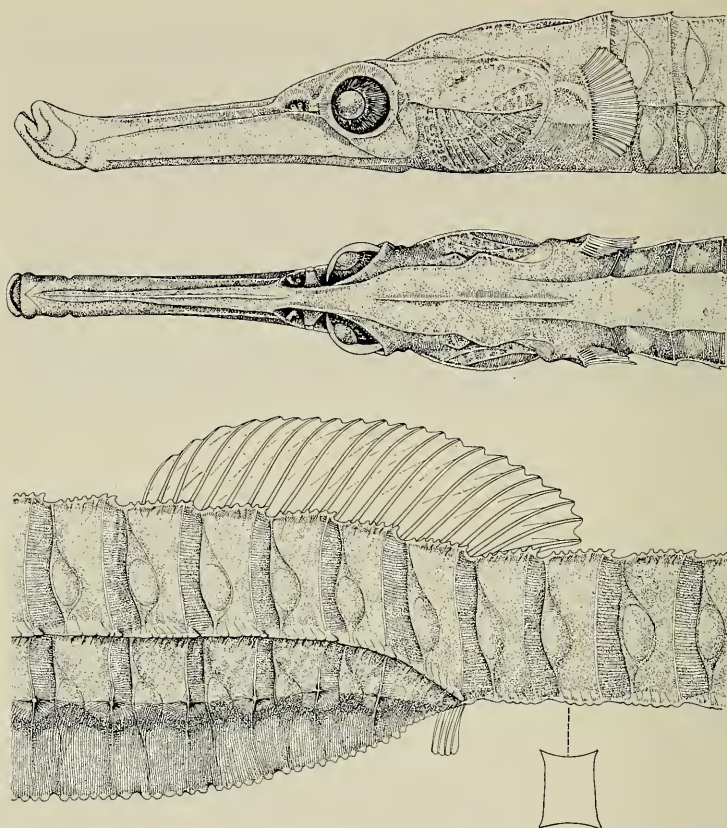


FIG. 6. *Choeroichthys cinctus*. Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail. From 36 mm SL male paratype, USNM 210061. Note blunt projections ("knobs") between lateral trunk ridge and ventral margin of trunk.

*brachysoma* (among 180 *brachysoma* from Pacific collections only 4 had more than 19 tail rings).

*Distribution:* *Choeroichthys cinctus* is known only from the Moluccas (Fig. 4) where it is sympatric with both *C. brachysoma* and *C. sculptus*. This species is known only from SCUBA collections within a 11–36.5 m depth range.

*Material examined:* Holotype: USNM 214567 (38.0 mm SL, male), Indonesia, Molluca Is., Namalatu, Latuhalat Is., ca. 03°47'S, 128°06'E,

ca. 150 m offshore, 11–18.3 m, 14 Mar. 1974, VGS 74–13. Paratypes: USNM 210061 (36.5 mm SL, male), Saparua, 13.7–16.8 m. BPBM 18610 (36.5 mm SL, male), Latuhalat Is., 36.5 m.

**Choeroichthys smithi**, new species

Figures 5 and 7

? *Choeroichthys* n. sp. Smith, 1951:53 (Delagoa Bay).

*Choeroichthys valencienni* (not of Kaup) Gabie, 1960:73, pl. 17 (misidentification, Mozambique).

*Choeroichthys suillus* (not of Whitley) Smith, 1963:529, pl. 78 (misidentification; Mozambique, Zanzibar ?). Smith, M. M., 1975:29 (common name: shortfin pipefish).

*Diagnosis*: Scutella not keeled; without distinct knoblike projections below lateral ridge; snout depth less than 3.0 ( $\bar{x} = 2.3$ ) in length; trunk rings 18–19; rings total 36–40; without distinctive markings on head or body; dorsal fin bicolored.

*Description*: Dorsal fin-rays 17–21 ( $\bar{x} = 19.4$ ); rings 18–19 + 18–21 = 36–40; subdorsal rings 3.25–4.5 ( $\bar{x} = 4.0$ ) + 0–1.25 ( $\bar{x} = 0.6$ ) = 3.75–5.25 ( $\bar{x} = 4.5$ ). Measurements (mm) of holotype follow: standard length 44.0; head length 8.0; snout length 3.4; minimum snout depth 1.5; length of dorsal fin-base 4.2; pectoral fin length 1.6; length of pectoral fin-base 1.4; caudal fin length 1.5; anal ring depth 2.5. See Tables 1–3 for additional data.

Ridges smooth; median dorsal snout ridge elevated posteriorly, usually obsolete anteriorly (Fig 7); lateral snout ridge distinctly arched; sub-orbital ridge present or obsolete; head not highly ornamented with lines or low ridges; pectoral cover plate with two principal ridges, otherwise mainly smooth. Trunk ridges notched or merely indented between rings, tail ridges distinctly notched; posterior angles of tail rings pointed but not produced as short spines. Scutella inconspicuous, without keels; vestiges of low projections occasionally present below lateral ridge on rear margin of some trunk rings, not produced as “knobs”; ring surfaces not distinctly depressed between ridges, ornamented with fine irregular lines but not striate. Odontoid processes reduced to minute projections, not readily visible under  $\times 30$  magnification; four projections on premaxilla and one or two on dentary of one dissected specimen.

Ground color tan to dark brown. Holotype with faint irregular streaks of darker brown on dorsum of head and all ring surfaces; without trace of stripe on snout or opercle and without distinctive markings on trunk or tail. Dorsal fin distinctly bicolored in all undamaged specimens, anterior portion brown with pale distal margin, pigmentation reduced posteriorly to a continuous brown band along proximal third or fourth of fin, postero-distal portion of fin immaculate. Caudal fin brownish with pale distal margin.

A 40 mm SL male (USNM 214566) has brood pouch folds originat-

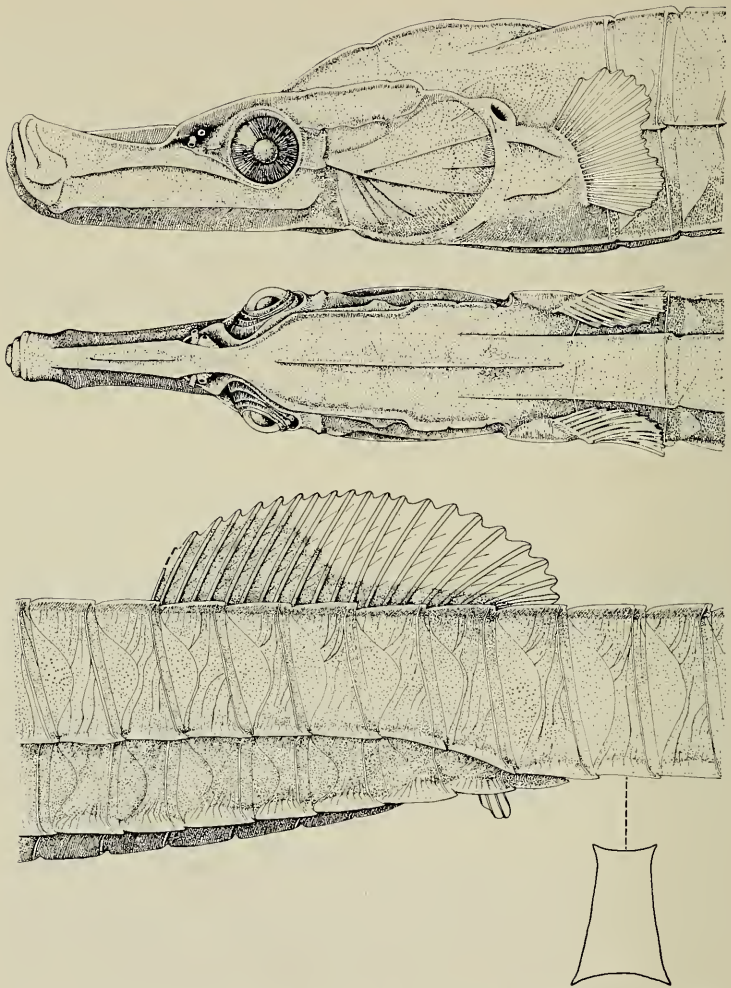


FIG. 7. *Choeroichthys smithi*. Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail ring. From 44 mm SL holotype, RUSI 3744.

ing at anterior margin of 3rd trunk ring and once contained two rows of about 19 eggs each in a single layer (eggs now mostly lost). The smallest examined male with eggs in pouch was 36.5 MM SL (RUSI 3775).

*Etymology*: Named in memory of the late Dr. J. L. B. Smith, collector of the present material.

*Comparisons*: The rather deep snout and distinctly arched lateral snout ridge of *Choeroichthys smithi* are very similar to those of *C. sculptus*. These species are, however, clearly separated by the keeled scutella of the latter (not keeled in *smithi*), coloration and by a number of meristic differences (Tables 1–3). Remaining congeners have slender snouts, linear lateral snout ridges and essentially unmarked dorsal fins (snout deep, ridge arched, fin bicolored in *smithi*). Meristic characters in these forms overlap to some extent, but total ring counts of *C. smithi* are greater than those of 92% of examined *C. brachysoma* and complete separation from *C. cinctus* is indicated by trunk ring counts (18–19 against 15 in *cinctus*).

*Discussion*: Smith (1963) apparently identified this material as *Choeroichthys suillus* Whitley on the basis of trunk ring counts and smooth character of head and body ridges. Compared with the holotype of *C. suillus*, this species has a deeper snout, arched rather than linear lateral snout ridge, fewer dorsal fin-rays (17–21 against 24), lacks the snout-opercular stripe and the dorsal fin is bicolored (stripe present, dorsal fin immaculate in holotype of *suillus*).

Attempts to locate the collection reported by Gabie (1960) have been unsuccessful, but the deep snout with arched lateral ridge, trunk ridge configuration and number of trunk rings (18 or 19) clearly refer the figured specimens to *C. smithi*.

*Distribution*: *Choeroichthys smithi* is known only from the coast of Mozambique (Fig. 4) where it is sympatric with both *C. brachysoma* and *C. sculptus*. There are no data on habitat or depth of capture. Specimens reported from Delagoa Bay and Zanzibar (Smith, 1951, 1963) were not available for study and their identity is uncertain.

*Material examined*: Holotype and 12 paratypes, 26.5–47.5 mm SL. Holotype: RUSI 3744 (44.0 mm SL, female), Mozambique, Inhaca, ca. 1951, J. L. B. Smith. Paratypes: RUSI 3775 (8 specimens); GCRL 13848 (1); USNM 214566 (2), Pinda. RUSI 4238 (1), probably Pinda.

### *Choeroichthys sculptus* (Günther)

Figures 8 and 9

*Doryichthys sculptus* Günther, 1870:185 (original description, Fiji Is.).

*Doryrhamphus macgregori* Jordan and Richardson, 1908:246, fig. (original description, Philippine Is.).

*Microphis ocellatus* Snyder, 1909:598 (original description, Tanegashima Is.).

*Diagnosis*: Scutella keeled; without knoblike projections below lateral ridge on posterior margins of trunk rings; snout rather short, its depth 3.5 or less in length ( $\bar{x} = 2.7$ ); rings total 40–45; sides of trunk usually

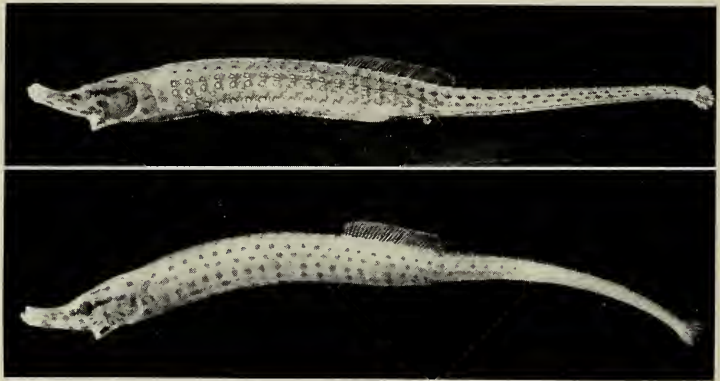


FIG. 8. *Choeroichthys sculptus* (Günther) GCRL 13817, Phoenix Is. Top: Male, 62 mm SL. Bottom: Female, 60 mm SL.

with 4 rows of dark spots or ocelli; trunk without bars; dorsal fin not bicolored.

*Description:* Dorsal fin-rays 27–34 ( $\bar{x}$  = 30.6); rings 18–21 + 21–25 = 40–44; dorsal fin on 4.0–7.25 ( $\bar{x}$  = 5.7) trunk and 0.5–2.5 ( $\bar{x}$  = 1.6) tail rings; subdorsal rings total 6.25–8.25 ( $\bar{x}$  = 7.3). See Tables 1–3 and 5 for additional data.

Ridges smooth to finely denticulate, infrequently serrate; median dorsal snout ridge (Fig. 9) low, somewhat elevated behind, sometimes obsolete anteriorly; lateral snout ridge arched; usually with one or two short suborbital ridges; other head ornamentation variable; pectoral cover plate with irregular low ridges or surface sculpture in addition to two principal longitudinal ridges. Trunk and tail ridges typically notched between rings; posterior angles of tail rings pointed but usually not produced as short spines. Scutella conspicuous, each with projecting ridge or keel so that trunk appears to have three lateral ridges between dorsal and ventral margins, and tail appears to have a median lateral ridge; similar keels present on dorsum and on venter of tail; keels on successive lateral tail scutella separate in young, often subcontinuous in large specimens; keels often with slight notch near middle of ring. Without knoblike projections on rear margins of trunk rings; ring surfaces not depressed between ridges, ornamented with irregular lines or ridges but not striate. Odontoid processes (Fig. 1) usually conspicuous under magnification, premaxillary projections rather bluntly pointed.

Ground color light tan to dark brown. Usually with diffuse dark blotch over nares and preorbital and with dark stripe on upper portion of opercle; often with narrow postorbital stripes on dorsum of head; venter of snout pale, head irregularly blotched elsewhere. Dorsum of trunk and tail plain or with irregular small dark spots and streaks;



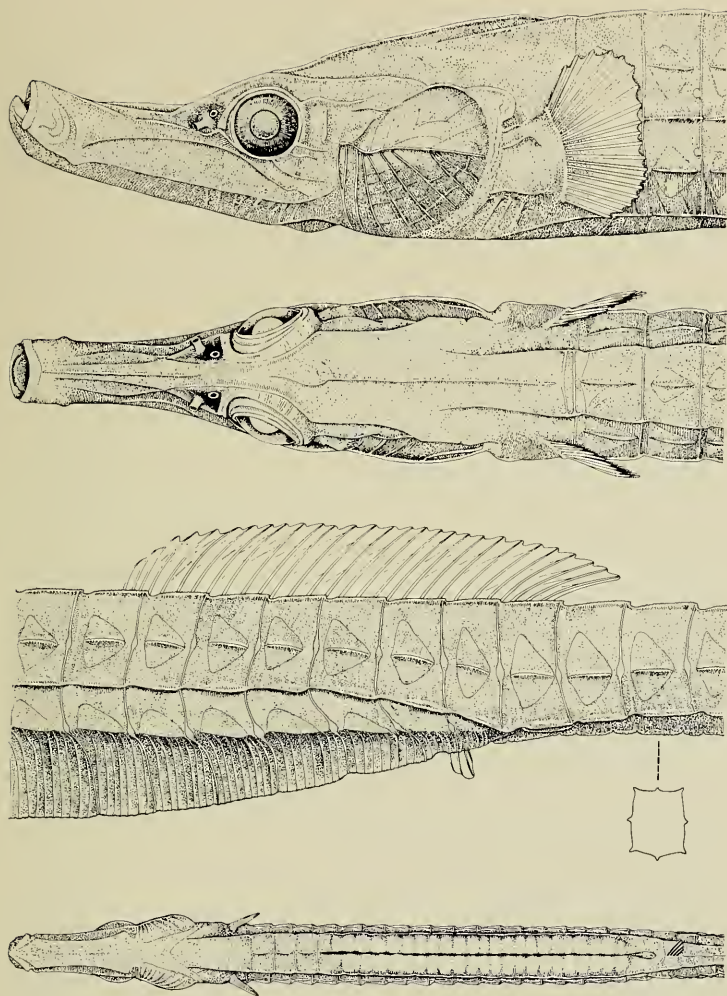


FIG. 9. *Choeroichthys sculptus*. Top to bottom: Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins and section through tail ring (from 53 mm SL male, GCRL 13195). Ventral aspect of trunk of mature male, illustrating brood pouch configuration and arrangement of eggs (54 mm SL, GCRL 13817).

dorsum of dark specimens often with pale bars (subequal to ring length), about 4 on trunk and 4–5 on tail. Males with or without row of dark spots (one per ring) between superior trunk ridge and keels of dorsolateral scutella; typically with three similar rows of larger dark-margined ocelli on remainder of trunk, one above lateral trunk ridge and two below; sides of tail usually with one or two rows of dark spots; pigmentation of brood pouch folds replicates ground color. Females and juveniles lack ocelli; trunk usually with four rows of dark spots or blotches on sides and two rows on venter; spots in one or two rows on sides of tail, often in single row on venter of some tail rings. Dorsal and pectoral fins mainly pale; caudal fin pale or brownish with pale distal margin.

Smallest male examined with brood pouch eggs was 46 mm SL and developing pouch folds were noted in 40–45 mm fish. A 50 mm specimen had pouch folds originating on 4th trunk ring and contained a single two-rowed layer of 29 eggs beneath 14 rings; a 70.5 mm fish contained a total of 68 eggs in two rows.

*Discussion:* This is a very distinctive form, readily separable from all congeners by the keeled scutella. Among examined material (Fig. 4, Table 5), trunk ring counts are modally 20 in collections along and near the east African coast; trunk rings are modally 19 in the Chagos Archipelago and eastward throughout the Indo-Pacific region. Tail ring counts are somewhat more variable in Pacific material, but total ring frequencies are similar in Indian Ocean and Pacific samples. East African fish are usually brown, whereas pale ground coloration is rather common in other areas.

Syntypes consist of single male and female specimens. The male (50 mm SL), in rather poor condition, retains no trace of brood pouch folds and I select the 53 mm SL female (BMNH 1858.12.27.106) as the lectotype of *Doryichthys sculptus*. Measurements (mm) follow: head length 9.4; snout length 4.4; minimum snout depth 1.4; length of dorsal fin-base 6.7; anal ring depth 2.4; there are at least 14 odontoid processes on the upper jaw and 18 on the lower (See Tables 1, 2 and 5 for meristic data).

*Distribution:* *Choeroichthys sculptus* ranges from Kenya and Mozambique to Makatea Is. in the Tuamotu Archipelago (Fig. 4). Smith's (1963) citation of a Red Sea record by Günther (1870) is incorrect, since only Fiji Island material was mentioned. With the exception of Duncker's (1915) questionable record ["Ostafrika, Abessinien (Mus. Calcutta)"], the species is unknown from the Red Sea. *Choeroichthys sculptus* has not occurred in collections from Ceylon, Malay Peninsula, western Indonesia or Australia and it is apparently replaced in these areas by *C. brachysoma*. Bathymetric data are limited but I have seen no collection records from depths greater than 2.4 m.

*Material examined:* 301 specimens, 35.0–79.5 mm SL, including lectotype and paralectotype. INDIAN OCEAN: Kenya: RUSI 3780, 3782, 3785. Latham Is.: USNM 214529. Mozambique: RUSI 3776–3779, 3781,

TABLE 1. Frequency distributions of trunk, tail and total rings in species of *Choeroichthys*.

	Species			
	<i>brachysoma</i>	<i>cinctus</i>	<i>smithi</i>	<i>sculptus</i>
Trunk Rings				
14	34			
15	142	3*		
16	75*			
17	4			
18	1		8*	9
19			3	230*
20				46
21				4
Tail Rings				
17	19			
18	123*		2	
19	96		1	
20	18	2*	4	
21		1	4*	56
22				134
23				70
24				23*
25				6
Total Rings				
31	4			
32	33			
33	99			
34	52*			
35	49	2*		
36	18	1	2	
37	1		1	
38			3	
39			3*	
40			2	45
41				121
42				87
43				32*
44				4
$\bar{x}$	33.6	35.3	38.2	41.4

\* Primary type.

TABLE 2. Frequency distributions of dorsal fin-rays, pectoral fin-rays and total subdorsal rings in species of *Choeroichthys*.

	Species			
	<i>brachysoma</i>	<i>cinctus</i>	<i>smithi</i>	<i>sculptus</i>
Dorsal fin-rays				
17			1	
18	1		2	
19	8		1	
20	43		2	
21	106*		3*	
22	83	1		
23	24	1		
24	6			
25	2	1*		
26	1			
27				4
28				10*
29				41
30				72
31				70
32				53
33				22
34				2
$\bar{x}$	21.4	23.3	19.4	30.6
Pectoral fin-rays				
18	17		1	2
19	65		7*	18
20	100		2	97*
21	33*	3	1	129
22	10	3*		16
23	1			1
$\bar{x}$	19.8	21.5	19.3	20.5
Total subdorsal rings				
3.75	4		2	
4.00	21			
4.25	56		2	
4.50	81		3	
4.75	65	1*	4*	

\* Primary type.

TABLE 2. (cont.)

	Species			
	<i>brachysoma</i>	<i>cinctus</i>	<i>smithi</i>	<i>sculptus</i>
5.00	38*	2	1	
5.25	10		1	
5.50	4			
5.75	1			
6.00	2			
6.25				6
6.50				16*
6.75				29
7.00				55
7.25				66
7.50				65
7.75				43
8.00				17
8.25				2
$\bar{x}$	4.6	4.9	4.5	7.3

3783, 3784, 3786. Madagascar: UMMZ 186037. Amirante Is.: ANSP 108998. Chagos Archipelago: USNM 214439, 214441, 214450. Maldive Is.: FMNH 75866. Cocos-Keeling Is.: ANSP 128424, 128427, 128432; GCRL 13181. Christmas Is.: WAM 21084, 21085. PACIFIC OCEAN: Philippine Is.: CAS 32286, 32288, 32289, 33307, 33308; CAS-SU 20202 (holotype of *Doryrhamphus macgregori*); USNM 137271. Ryukyu Is.: USNM 62946, 74536 and CAS-SU 21133 (holotype and two paratypes of *Microphis ocellatus*); USNM 214442. Molucca Is.: AMS IB.2022; BPBM 18533. New Guinea: CAS-SU 26688. Palau Is.: CAS 32283; USNM 154637. Mariana Is.: ANSP 114272; CAS 32282. Solomon Is.: CAS 24177. New Hebrides: AMS IA.783, I.6421-4, I.6573; BPBM 10741; CAS 19445, 32285; CAS-SU 25081; FMNH 21081, 21082. Marshall Is.: FMNH 42867; LACM 7329; USNM 166816. Gilbert Is.: MCZ 35302. Fiji Is.: ANSP 101339; BMNH 1858.12.27.106 (lectotype of *Doryichthys sculptus*), 1858.12.27.107 (paralectotype); CAS-SU 24837, 24896; FMNH 21076-21080; GCRL 13195. Phoenix Is.: GCRL 13816, 13817; USNM 116096, 116097, 214440, 214443-214446, 214449. Tonga Is.: BPBM 10762. Samoa Is.: USNM 116094, 116095, 116098. Cook Is.: AMS IA.5374; BPBM 17677. Line Is.: ANSP 75797; USNM 214448. Society Is.: CAS 32280; MCZ 11734; USNM 214447.

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TABLE 3. Measurements (mm), mean ( $\bar{x}$ ), standard error of mean ( $s$ ), standard deviation ( $\sigma$ ), regression equation and coefficient of correlation ( $r$ ) for selected characters in species of *Choerichthys*. Head length ( $y$ ) against standard length ( $x$ ); in remaining regressions, head length is the x-variate. Correlation coefficients significant at  $p = .01$ .

Species	Character	N	Range	$\bar{x}$	s	$\sigma$	Regression equation	r
<i>brachysoma</i>	Standard length	198	13.5-62.5	44.9	0.58	8.15		
	Head length	198	4.0-11.9	9.0	0.08	1.19	$y = 3.169 + 0.130x$	0.889
	Snout length	198	1.8-7.7	4.5	0.05	0.74	$y = 0.919 + 0.596x$	0.954
	Length of dorsal fin-base	194	1.9-6.8	4.6	0.07	0.95	$y = -1.272 + 0.657x$	0.819
<i>sculptus</i>	Standard length	182	35.0-79.5	53.6	0.62	8.35		
	Head length	182	7.0-12.2	9.2	0.07	0.93	$y = 3.894 + 0.098x$	0.878
	Snout length	182	3.0-5.7	4.1	0.04	0.49	$y = -0.344 + 0.482x$	0.914
	Length of dorsal fin-base	182	5.0-13.1	7.9	0.11	1.49	$y = -1.892 + 1.069x$	0.670
<i>smithi</i>	Standard length	11	26.5-47.5	37.4	1.68	5.56		
	Head length	11	5.9-9.0	7.2	0.24	0.81	$y = 1.898 + 0.142x$	0.977
	Snout length	11	2.5-3.8	3.1	0.11	0.36	$y = 0.005 + 0.430x$	0.942
	Length of dorsal fin-base	11	2.6-5.3	3.6	0.22	0.73	$y = -2.488 + 0.850x$	0.941
<i>cinctus</i>	Standard length	3	36.5-38.0					
	Head length	3	9.3-10.0					
	Snout length	3	5.1-5.8					
	Length of dorsal fin-base	3	3.4-4.0					

TABLE 4. Frequency distributions of trunk, tail and total rings in populations of *Choeroichthys brachysoma*.

Locality	Trunk rings							Tail rings							Total rings				
	14	15	16	17	18	17	18	19	20	31	32	33	34	35	36	37			
Red Sea																			
Israel	2		2				1	3					3	1					
Ethiopia			14	3			4	10	3				3	9	5				
Indian Ocean																			
Mozambique	2		12				1	12	1				3	10	1				
Aldabra Is.			3				1	1	1				1	1	1				
Seychelles Is. †			16				5	11					5	11					
Mauritius			3				1	2					1	2					
Maldive Is.			4					1	3					1	3				
Ceylon	1		9					5	5					6	4				
Thailand			3					2	1					2	1				
Batu Arch.			1*				1*							1*					
Australia	1						1												
Pacific Ocean																			
Singapore	20	1					2	12	7		2	12	6	1					
Gulf of Thailand	2	1						2	1		1	1	1	1					
Philippine Is.	4	4	1				3	1	1		3	1	3	1	1				

\* Holotype of *C. brachysoma*.

† Including Amirante Is.

TABLE 4. (cont.)

Locality	Trunk rings							Total rings							Tail rings						
	14	15	16	17	18	17	18	19	20	31	32	33	34	35	36	37					
Moluccas Is.				4	1																
Palau Is.	6	11		1		5	10	2		2	6	8	1								
New Guinea		1	1				1	1					2								
Australia	5	103	1		1†	11	68	31†			13	68	28			1†					
Mariana Is.				1					1						1						
Solomon Is.	1	10				1	8	2		1	9	1									
New Hebrides				1			1					1									
Cook Is.				1	1			2						1	1						
Society Is.						2		1	1					1	1						

† Holotype of *C. strillus*.



TABLE 5. Frequency distributions of trunk, tail and total rings in populations of *Choeroichthys sculptus*.

Locality	Trunk rings				Tail rings					Total rings				
	18	19	20	21	21	22	23	24	25	40	41	42	43	44
Indian Ocean														
Kenya			3		2	1					2	1		
Latham Is.			1		1						1			
Mozambique		1	28	4	8	20	5			1	5	20	7	
Madagascar			1		1							1		
Amirante Is.			2		1	1					1	1		
Chagos Arch.	1	10	1		4	8				4	8			
Maldive Is.		1			1					1				
Cocos-Keeling Is.		12			11	1				11	1			
Christmas Is.		2			2					2				
Pacific Ocean														
Philippine Is.	1	8	1		1	8	1			1	8	1		
Ryukyu Is.		2	1		2	1				1	1	1		
Moluccas Is.	1	1				1	1				2			
New Guinea		2			2					2				
Palau Is.		3			1	2				1	2			
Mariana Is.		22			2	13	5	1	1	2	13	5	1	1
Caroline Is.		2			2					2				
Solomon Is.		1			1					1				
New Hebrides	1	40	3		10	12	19	3		8	15	17	4	
Marshall Is.	1	2				3				1	2			
Gilbert Is.			1		1						1			
Fiji Is.	1	17*				1	12	5*			2	11	5*	
Phoenix Is.	3	61	2		17	28	6	12	3	17	28	7	11	3
Tonga Is.		2			1	1				1	1			
Samoa Is.		33	1		1	16	15	2		1	15	16	2	
Cook Is.		2			1	1				1	1			
Line Is.		3	1		1	1		2		1	1	1	1	
Society Is.		2				1	1				1	1		
Tuamotu Arch.		1				1					1			

\* Lectotype.

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